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Macon County - Solid Waste Management System Analysis

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In 1973, the Illinois Pollution Board adopted new regulations for sanitary landfills. These regulations are enforced by the Illinois Environmental Protection Agency. The permit and inspection provisions established under these regulations are among the most comprehensive and vigorous in the United States. Each landfill operator is required to apply for a permit by April 27, 1974. The expense of meeting Illinois design and operating standards has and probably will cause some marginal landfill operations to close, thereby eliminating some environmentally unacceptable, but convenient, disposal sites.

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MACON COUNTY—
SOLID WASTE MANAGEMENT SYSTEM ANALYSIS

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MACON COUNTY
SOLID WASTE MANAGEMENT
SYSTEM ANALYSIS

Roy F. Weston, Inc.

(IIEQ Document No. 74 - 9)

Project No. 40.001

State of Illinois

Illinois Institute for Environmental Quality

April, 1974

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The Need for Advance Planning in Illinois

In July, 1970, the Illinois General Assembly passed the Illinois Environmental Protection Act. This law expresses the determination of the people to improve the quality of the environment in Illinois. The Act addresses problems of air, water, land and noise pollution.

In 1973, the Illinois Pollution Control Board adopted new regulations for sanitary landfills. These regulations are enforced by the Illinois Environmental Protection Agency. The permit and inspection provisions established under these regulations are among the most comprehensive and vigorous in the United States. Each landfill operator is required to apply for a permit by April 27, 1974. The expense of meeting Illinois design and operating standards has and probably will cause some marginal landfill operations to close, thereby eliminating some environmentally unacceptable, but convenient, disposal sites.

The dwindling number of solid waste disposal sites has caused concern among municipal officials and private solid waste companies. Efforts to aquire new sites have often been thwarted by citizens who recognize the need for such facilities, but would rather see them located somewhere else.

The increased costs associated with everything these days have strained municipal budgets. Solid waste management is a large budget item. Elected officials are asking: Can this be reduced?

Over half of the solid waste in Illinois is managed by private companies. Their costs are increasing, and so are the rates charged to their clients. Public officials are asking: What is the cost of solid waste management? Should we go into business for ourselves?

In 1973, the energy crisis reinforced the long-standing argument by

environmentalists that something should be done to recover the resources going into solid waste. Solid waste managers now must cope with the added complexities of unproven recovery systems and an uncertain market for recovered commodities.

These and other pressing problems require planning. This study provides a basis for that planning by examining the economics of current solid waste management practices and proposed regional management strategies.

State Solid Waste Plan

The State Solid Waste Management Planning Project will examine the solid waste needs of Illinois and make recommendations as to actions that can be taken by the State to improve solid waste management generally. The Solid Waste Management Task Force of the Illinois Institute for Environmental Quality recognized from the start that solid waste management is a local responsibility and is subject to the specific desires of the people as to the services desired and the manner of satisfying these desires. Consequently, the task force suggested that the principal thrust of the State planning project should be to assist the work of local and regional planners who must prepare the specific recommendations for local officials.

This report is an analysis by the State and its consultants of several alternatives available to a specific region. Basic data used in the analysis was gathered by the regional planners, processed by the consultants, and rechecked by the regional planners. Elsewhere in the State plan, the planner will find reference data on the natural features of the State which will have an impact on solid waste management activities.

The Analytical Process

People and their activities produce solid waste. The first step in the planning procedure was to determine population and employment. Basic population projection data was generated by Argonne National Laboratory using historic census data and a predictive model. These projections were checked by the regional planner using local data and projections by the Illinois Office of Planning and Analysis (OPA). Tables 1 and 3 show examples of population and employment projections. Employment data was taken from the

Table 1

PROJECTED POPULATION EXAMPLE

LOCATION	1970	1975	1980	1985	1990	1995	2000
City A	305	305	350	360	390	400	410
City B	39,992	44,500	48,500	51,400	54,000	57,100	59,800
City C	2,435	2,780	3,010	3,230	3,440	3,690	3,910
City D	26,396	27,900	34,400	39,100	43,800	49,000	54,100
SUB TOTAL	69,128	75,385	86,260	94,090	101,630	110,190	118,220
UNINCORPORATED	21,754	23,400	24,200	24,800	25,300	25,900	26,400
COUNTY TOTAL	90,882	98,785	110,460	118,890	126,930	136,090	144,620

Table 2

AN ILLUSTRATION METHOD OF MUNICIPAL SOLID WASTE GENERATION

(1) Political Subdivision	(2) 1970 Population	(3) Area $(mi.^2)$	(4) Population Density (2) ÷ (3)	(5) Log (4)	(6) 1.54 X (5)	(7) Generation Factor (6) - 0.68 #/cap./day	(8) Collection Rate (2) x (7) #/day	(9) Collection Rate (8) ÷ 285.7 ton/week
City A	305	0.17	1,794	3.25	5.01	4.33	1,320	4.6
City B	39,992	11.37	3,517	3.55	5.46	4.78	191,161	699.
City C	2,435	1.28	1,902	3.28	5.05	4.37	10,641	37.
City D	26,396	6.06	4,356	3.64	5.60	4.92	129,868	455.
Co. Remainder	21,358	1,157.	18.7	-	-	3.4	72,617	254.

Table 3

AN EXAMPLE OF THE EMPLOYMENT PROJECTIONS

SIC	1971	1975	1980	1985	1990	1995	2000
City B 207	1,000	1,000	1,000	1,000	1,000	1,000	1,000
2432	25	29	31	35	36	40	42
3272	3	0	0	0	0	0	0
358	1,500	2,470	2,750	3,020	3,220	3,630	4,010
City C 243	15	15	15	15	15	15	15
271	4	1	0	0	0	0	0
City D 275	15	21	27	32	37	43	49
278	60	79	100	140	170	210	240
301	225	225	225	225	225	225	225
327	32	32	35	35	35	35	35

Illinois Manufacturers' Association Directory as an historic data base. Employment projections are expressed in 3- and 4- digit Standard Industrial Classification (SIC) code (Table B-1, Appendix B).

Approved population projections are then multiplied by waste generation factors to give the municipal solid waste load (i.e. the residential and commercial wastes generated within a community).

Table 2 is an example of a tabular solution in which population is translated into a solid waste generation rate. (A more detailed explanation of the columns and the computational method is contained on Page B-1, Appendix B). Similarly, Table 4 gives a sample calculation in which employment is translated into tons of industrial wastes. The conversion factors (Table B-1, Appendix B) for converting employment data into tons of waste were derived by the consultant from data supplied by the USEPA. Table 5 shows, where there is no centrally located municipality, how the residential waste from unincorporated areas is allocated (on the basis of percentage of area) and combined with municipal and industrial wastes for the purpose of subsequent analyses. Wastes from unincorporated areas are considered to be located at the centroid of the township.

For long-term planning, consideration must be given to the annual change in generation rates. The computational methodology is shown on Table 6. A 2% and 3% per year increase in the generation factor was used for cities with more than 10,000 people and less than 10,000 people respectively.

Total waste quantities for the present (1973) and a future date (1990) are presented on Table 7. These waste quantities are, in turn, provided as input to a computerized model. The computer then determines the cost of hauling waste from the centroid of each source to each specified processing or disposal site. Transportation costs are added to site annual operating costs to determine a total annual system cost. It is within the capability of the computer model, if it is so instructed, to select the combinations of sources, processing facilities and ultimate sites which given the least (optimum) system cost.

Table 4

EXAMPLE OF INDUSTRIAL WASTE LOADING CALCULATION

(1) Location of Political Subdivision	(2) SIC Code	(3) Number of Employees in 1971	(4) Generation Factor (Ton/Empl/Yr)	(5) Production Rate (Ton/Yr) (3) x (4)	(6) Production Rate (Tons/Week) (5) ÷ 52	(7) Total Industrial Waste For Each Source (Ton/Week)
City A						0
City B	207	1,000	3.3	3,300.	63.4	
	2432	25	232.	5,800.	111.5	
	3272	9	154.	1,310	26.1	
	358	1,500	1.5	2,250	42.2	243.2
City C	243	15	21.7	3 325.5	6.3	6.3
City D	275	15	1.1	16.5	-	
	278	60	2.6	156.	3	
	301	225	3.7	833.	16	
	327	32	15.	480.	9.2	28.2

Table 5

EXAMPLE OF COMPOSITE LOADING SHEET FOR BASE YEAR - 1973

Source Name	I.D#	SIC Load (Ton/Week)	Municipal Load (Ton/Week)	Area for Division of County Remainder $(Miles)^2$	Load due to County Remainder (Ton/Week)	Total Load (Ton/Week)
City A	101	-	4.6	9.7	54.6	59.2
City B	102	243.2	699.	10.	56.3	998.5
City C	103	6.3	37.	10.4	58.6	101.9
City D	104	28.2	455.	15.	84.5	567.7
				45.1	253.98	
County Remainder -		-	254			1727.3

Table 6

AN EXAMPLE OF THE COMPOSITE SHEET FOR WASTE LOADS (Ton/Week) FOR 1990

Source Name	I.D.#	1990 Industrial Load (Ton/Week)	1970 Generation Rate (#/cap./day)	% Increase Per Year	Total % Increase	1990 Generation Factor (#/cap./day)	1990 Municipal Waste Loads (Ton/Week)	County Area Factor	County Remainder Based on Area (Ton/Week)	1990 Total Waste Loads (Ton/Week)
City A	101	-	4.33	3	60	6.9	9.4	36	94.3	103.7
City B	102	360	4.78	2	40	6.35	1264.	48	125.7	1389.7
City C	103	6	4.37	3	60	6.99	84.3	64	167.7	252.
City D	104	36	4.92	2	40	7.87	1207.	36	94.3	1301.3
County Remainder			3.4	3	60	5.44	482	184		3046.7

Table 7

EXAMPLE OF THE STUDY PERIOD SOURCE INVENTORY

SOURCE NAME	SOURCE ID NO.	1973 VALUES QUANTITY (Tons/Week)	1990 VALUE QUANTITY (Tons/Week)
City A	101	59.2	103.7
City B	102	998.5	1389.7
City C	103	101.9	252.
City D	104	567.7	1301.3

In addition to sources and waste quantities, the computer must be given cost parameters for transportation and for the operation of the solid waste management system specified. Unit costs for the disposal systems tend to be lower as the quantities increase. Such variable cost factors are best described by cost curves which were incorporated into the computer input. These cost curves are shown in Figs. B-1 and B-2, Appendix B.

In developing the planning factors and cost curves, the consultant was faced with the problem of picking a finite value for a given function when, in actuality, that function could be described by a range of values. The values given here are neither the highest nor the lowest, but an estimate of current conditions. They were adjusted to 1973 cost levels using the Engineering News-Record construction cost index. Where appropriate, assumptions are listed.

Computations do not include the cost of solid waste collection. It is assumed that, regardless of the management system used, the waste must be collected. Whether it is collected once a week or twice a week, at the curb or at the back door, in plastic bags or in 32 gallon cans, are matters of local preference. The alternatives addressed in this study include the cost of moving from the centroid of the collection area to an intermediate or final disposal site.

Aside from taking the drudgery out of the thousands of calculations required, the computerized model permits the planners to examine a range of management alternatives. The strategies thus examined and reported here were proposed and analyzed by the regional planner with assistance from the State's consultants.

Resource Recovery

These analyses take a conservative view of the economics of resource recovery alternatives. As of March, 1974, there were no large scale resource recovery systems operating in the United States. Certain demonstrations projects are operating successfully in Franklin, Ohio and St. Louis, Missouri. Larger systems have been designed and several are under construction. We can

predict operating and capital costs better than we can predict the off-setting revenues from the sale of recoverable resources. Table 9 gives recent prices for the secondary materials present in typical municipal waste. These prices are subject to the usual variations of the commodities market, as well as regional variations in transportation costs. Table 10 describes eight levels of resource recovery activities and the expected revenue (based on Table 9 prices). The decision to adopt a resource recovery system will entail an evaluation of the risk involved in the fluctuating market values.

Uses of This Report

The results of this analysis are intended to assist the regional planner in preparing recommendations for local decision makers. The analytical techniques used are based upon averages and generalized planning factors developed in 1973 and cannot be expected to reflect the exact local cost situation. The usefulness of this regional analysis is to show the relative economic merits of alternate management systems, thus enabling the planner to separate the most feasible alternatives from the least feasible.

This report includes basic data, planning factors, and sample calculations so that the regional planner can make specific adjustments later on. It is to be emphasized that the least cost solution is not necessarily the best. The recommended solution will be that which combines economy with regional desires and constraints. To prepare such recommendations is the task of the regional planner.

Future Planning

It is expected that regional planners will need to up-date their plans and to consider other strategies. It is the intention of the Illinois Institute for Environmental Quality to maintain the capability for providing these regional analyses.

TABLE 9

RESOURCE RECOVERY VALUE FOR FERROUS AND NONFERROUS METALS, GLASS, FIBERS AND HEAT VALUE

Materials Recovered	Conc. In MSW (%)	Recovery (%)	T /100T MSW	Delivered Price	Trans. Charge (5)	Net Credit	Credit $/Ton Of Input Solid Waste
Ferrous Metal (6)	7.5	100	7.5	$56	$ 46	$11.7	$ .82
#2 Bundle	7.5	100	7.5	20 (10-30)	6	10	0.75
Madison (3)	7.5			51	6	14	1.05
Scrap Steel Jan. 73 (4)				86	6	45	
Jan. 74 (4)						80	
Scrap Steel Incinerator Residue			7.5	12 (10-14)	5	7 (5-9)	.53 (.40-.72) (.42 (6))
Aluminum	1.0	100	1.	200	50	150	1.50
Copper Zinc Fraction	.5	100	.5	240	50	190	.95
Copper Scrap (Jan. 73) (4)				860	50	810	
(Jan. 74) (4)				1360	50	1310	
Tin Scrap (Madison (3))				4000	50	3950	
Glass (Sorted by color)	9.	44	4.	16	6	10	.40
Mixed Glass Fines	9.	70	6.3	5	6	- 1	-0.06
Fourth Forest Pulp	40. (Dry Basis)	45	18.	25	8	17	3.06
Newsprint (July 73) (4)			8	18	8	10	0.80
(Nov. 73) (4) Separated			8	35	8	27	2.16
(Jan. 74)			8	60	8	52	4.16
Paper (6)			15.			15	2.25
Energy Recovery							
Electric Energy (6)			6.67×10^4 Kwhr.			$.006/Kwhr.	4.00
Shredded Refuse Heat Value (7)			7.5×10^8 Btu/100 Ton			.50¢/M Btu	3.75
Total Combustible	75. (Wet Basis)	100	75.			(1.)	4.95
Combustible After Fiber Recovery	75. (Wet Basis)	66	50.			(2.)	3.3
Synthetic Fuel Oil (6)			4.80×10^8 Btu/Ton			$.8-/10^6$ Btu	3.36
Synthetic Fuel Gas (6)			6.7×10^8 Btu/Ton			$.50/10^6$ Btu	3.33
Steam			175				3.33
			175	1.90 @ .95/1000#			

1. Produces 450 Kilowatts-hours of Electricity/Ton, Valued at 1.1 Cent per Kilowatt-hours.
2. Producers 300 " " " " " " " " " " " "
3. From Madison Wisconsin Shredding and Landfill Operation.
4. Wall Street Journal - January 31, 1974
5. Transport Cost for 1973 Average Used Through-out, Value Fluctuates
6. Resource Recovery - The State of Technology, pg. 25
7. Commonwealth Edison 1974

This Table summarizes the by-product credits that may be realized by reclamation of recyclable materials from a ton of MSW. The credits reflect 1973 conditions and assume reasonable transportation charges to proximate recycling plants; i.e., the credits are based on delivered prices and representative concentrations of the salvaged materials in MSW. Extreme fluctuation can be seen in a one year period. Selection of appropriate value must be based on transport distance and market demand.

Table 10

TABLE OF RESOURCE RECOVERY VALUES FOR VARIOUS SYSTEMS

A. Small operation - magnetic separation of cans
$1.05/Ton of Input Municipal Solid Waste (M.S.W.)

B. Cans and Paper Recovered
$1.05 Cans
3.06 Paper - based on separate collection
$4.11/Ton of Input M.S.W.

C. Cans, Paper, Aluminum, Copper - Zinc Fraction Recovered
$1.05 Cans
3.06 Paper - separate collection
1.50 Aluminum
.95 Copper - Zinc Fraction
$6.56/Ton of Input M.S.W.

D. Cans, Paper, Aluminum, Copper-Zinc, and Fraction Heat Recovery
$1.05/T for Cans
3.06/T for Paper separate collection
1.50/T for Aluminum
.95/T for Copper-Zinc Fraction
3.00/T for Heat Recovery after Fiber Recovery
$9.56/Ton M.S.W. Input

E. Incineration with Residue Recovery. Recover only Steel Cans
$ .53 Cans from incinerator Residue

$ .53/Ton M.S.W

F. Metal Recovery, Heat Recovery, Heat Recovery of Shredded M.S.W.
$1.05/T for Magnetic can separation
1.50/T for Aluminum
.95/T for Copper-Zinc Fraction
3.75/T for Shredded Fuel Value

$7.25/T of Input M.S.W.

G. Incineration with Residue Recovery and Heat Recovery
$ .53/T for Cans from incinerator Residue
1.50/T for Aluminum
.95/T for Copper-Zinc Fraction
4.50/T for Heat Value

$8.00/T for Heat and Material Recovery of M.S.W.

H. Source separation and separate collection of newsprint
$ .80-4.16/Ton of input Municipal Solid Waste (M.S.W.)

CAUTION: This table shows the value of recovered resources for 8 theoretical recovery systems. It is based on the "credit $/Ton" column of Table 9, and is subject to the conditions and assumptions stated. Tables 9 and 10 may need to be modified to reflect local markets and transportation costs.

Management Alternatives for Macon County

The Macon County Planning Commission has identified seven (out of a total of 63) landfill sites which have sufficient capacity to be considered for operational purposes. Most of the small, marginal landfills will close as a result of State permit requirements. The seven landfills can handle the entire collected refuse waste load of the county. The privately-owned Macon County Landfill has the largest operational capacity (4800 tons/week). However, its expected lifetime is only one and one-half years. At that time, the six remaining landfills could absorb the total wasteload, but would be quickly filled to capacity. Because of their limited capacity, because they are operated primarily for commercial and industrial users, and because of the high operating costs expected from small-scale operations, these six small landfills are not considered to be viable short or long-term alternatives.

Present Problem

All solid wastes in Macon County are collected by private haulers. Most collected wastes are delivered to the Macon County Landfill (private) with little attention given to the problem of reducing haul distances and costs by using other, more convenient landfills. The most serious problem facing these haulers is what to do when the Macon County Landfill closes 1½ years from now. The crisis nature of this problem is not apparent. County officials and planners are aware that it normally takes about two years to procure land, obtain a permit, and construct a landfill site.

Computational Method

Projections of population and employment were calculated using the method described in Chapter 1. The results are tabulated in Tables 1, 2 and 3 of Appendix A. A summary of geological information for Macon County (Appendix A) indicates soil and groundwater conditions favorable to the use of sanitary landfills.

Short-term Analysis

Short-term planning solutions include those alternatives that could

be reasonably expected to be operational within two to three years of the plans acceptance. Each alternative analyzed is described by a pair of diagrams. The first diagram summarizes the sources, sites, quantities, costs and assumptions. The second (insert) diagram shows the disposition of waste loads from populated areas. Conclusions are discussed below:

Alternative 1: The existing system is operating at a favorable unit cost, largely because most of the waste goes to a single landfill which is conveniently located in relation to most of the population. The Macon County Landfill (501) is not now in compliance with the landfill regulations and, as previously stated, it is expected to be filled in mid-1974. If at that time the waste is diverted to landfills 502, 503, 504, 505, 506, and 507, they too, will be filled during 1975. A possible short-term solution would be to open a single new landfill (601) in the vicinity of landfills 501 and 502.

Alternative 2: What is the possibility of an immediate saving by using a transfer facility in combination with a single landfill? A new landfill (601) located in the same area as 501 and 502 would probably face fewer community objections.

This final disposal site in combination with a transfer station located in the northeastern corner of Decatur could conceivably reduce cross-town traffic and haul costs. A comparison of Alternatives 1 and 2 shows a slight saving in total system cost. Haul costs were reduced and the added cost of the transfer station was offset by the elimination of several small, uneconomical landfills.

Long-term Analysis

Long-term solutions enable the planner to consider a wider range of alternatives than are possible in short-term situations, such as the one now facing Macon County. Ideally, the long-term solution would build upon the facilities provided for short-term needs. Complex and costly systems also require greater care in estimating waste quantities and facilities construction and operating costs.

COST OF EXISTING SYSTEM
MACON COUNTY

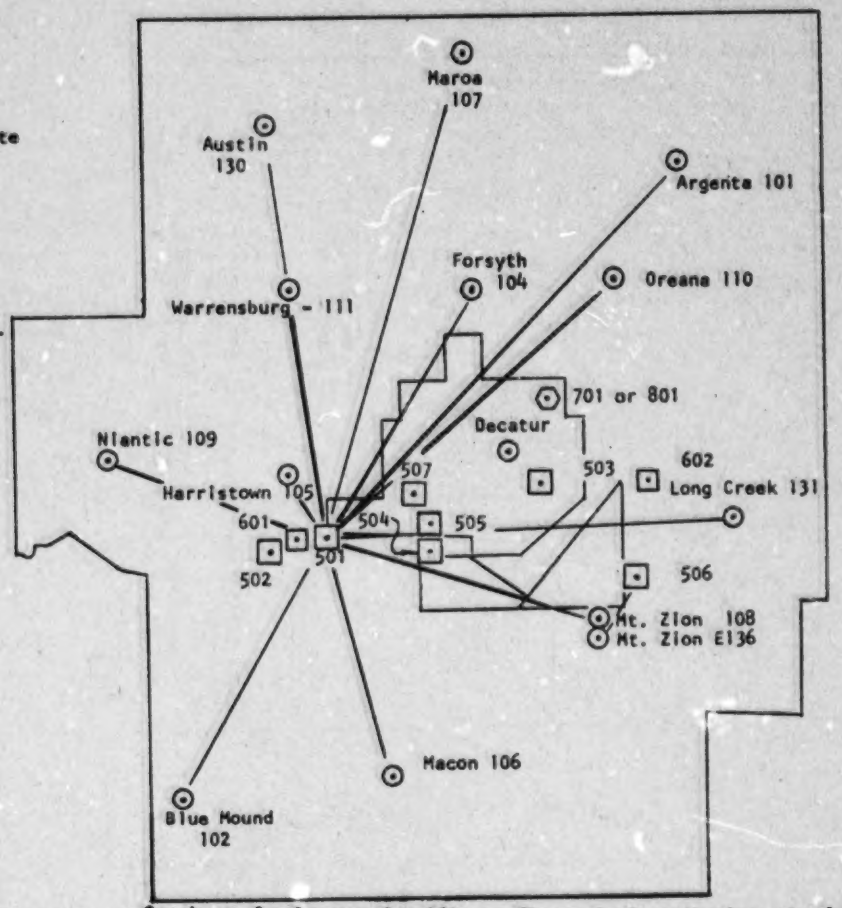
ALTERNATIVE #1

Key:

____ From Source to Ultimate

- - - From Source to Intermediate

. . . From Intermediate to Ultimate



See Inset for Decatur Specifics

HAUL COST ASSUMPTIONS

PACKER Haul Cost $4.36/Ton-Hr.

TRANSFER Haul Cost $1.40/Ton-Hr.

Total Facility Annual Cost	$407857
Total System Haul Cost	927891
Total System Annual Cost	$1335748
Total System Annual Unit Cost	$5.37/Ton
Tons Handled Per Week	4786 Tons per week

⊙ Sources

⊡ Ultimate Facilities - Land Fills

ID #	Name
*501	Macon County
*502	Cummins & McKinney
*503	Staley
*504	Bath
*505	Rhodes
*506	Cummins
*507	Moore's
601	New 501/502 Fill
602	New Fill Staley

⊙ Intermediate Facilities

ID #	Name
701	Transfer Station
801	Incinerator

*Indicates Facility In Use

This summary describes an evaluation of the present system. The seven sites within the county are listed as recipients of all county generated wastes. The quantities of refuse for each source are the result of waste factors generated using population and employment data. The source-site pairings and the facility information provided herein represent data provided by the local planning agency and the IEPA.

The analysis emphasizes the following facts:

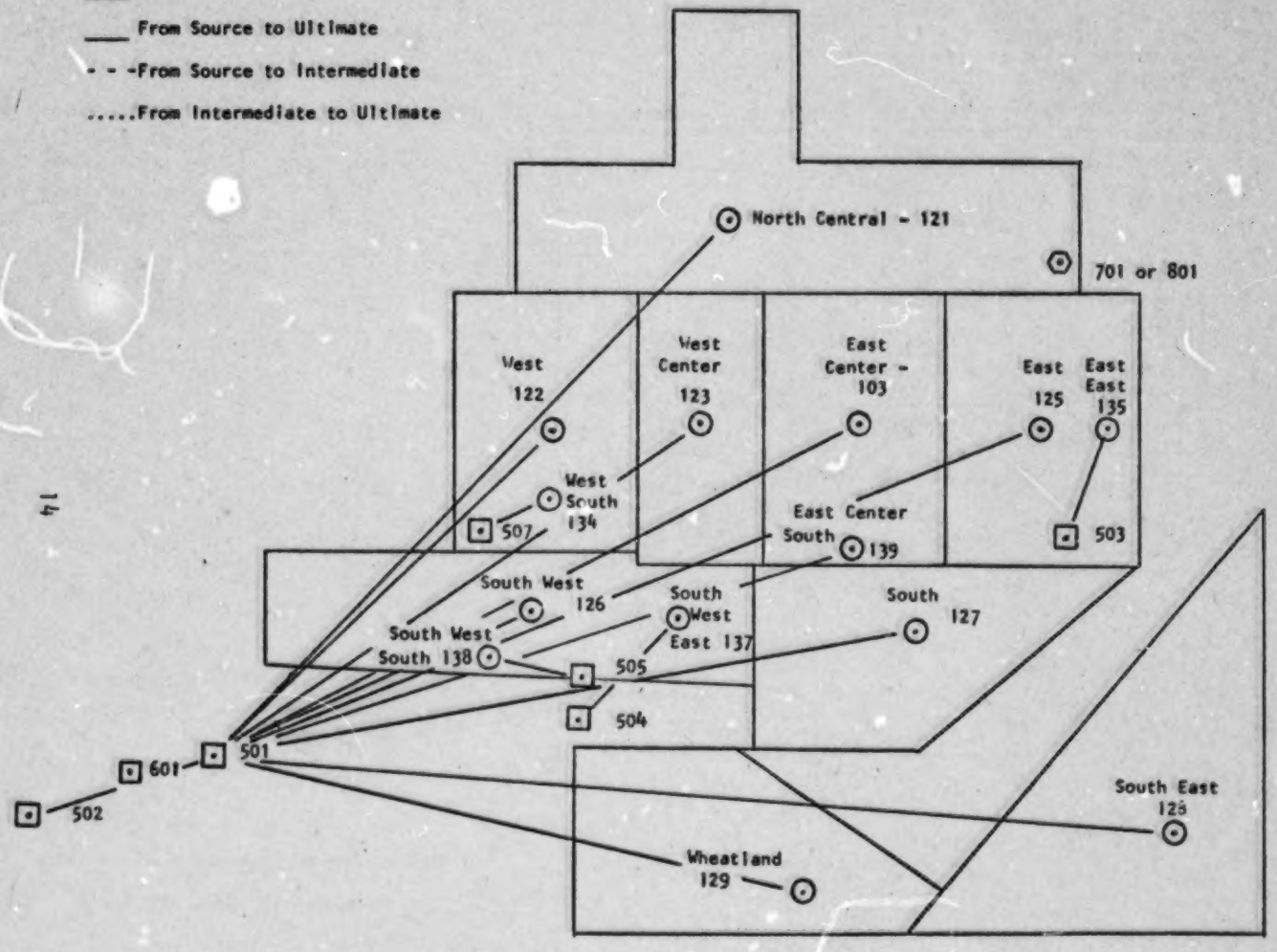
1. The small landfills have a high unit cost.
2. Major sources and site area is Decatur.
3. The major site will be completed within 1 or 2 years, immediate decisions are required.
4. Almost all waste goes to one fill.

Directions for further analysis:

1. Optimize haul system for cost benefits.
2. Consider a transfer station in the northeastern part of Decatur.
3. Select future landfill sites.
4. Eliminate the high unit cost, small operation landfills.
5. Consider the use of processing facilities to reduce the quantity of waste requiring disposal.

MACON COUNTY INSERT
DECATUR, ILLINOIS

Alternative #1



MACON COUNTY
USE OF A NEW LANDFILL BETWEEN 501 and 502 (601) WITH
A TRANSFER STATION (701) IN NORTHEASTERN DECATUR.

ALTERNATIVE #2

Key:

____ From Source to Ultimate

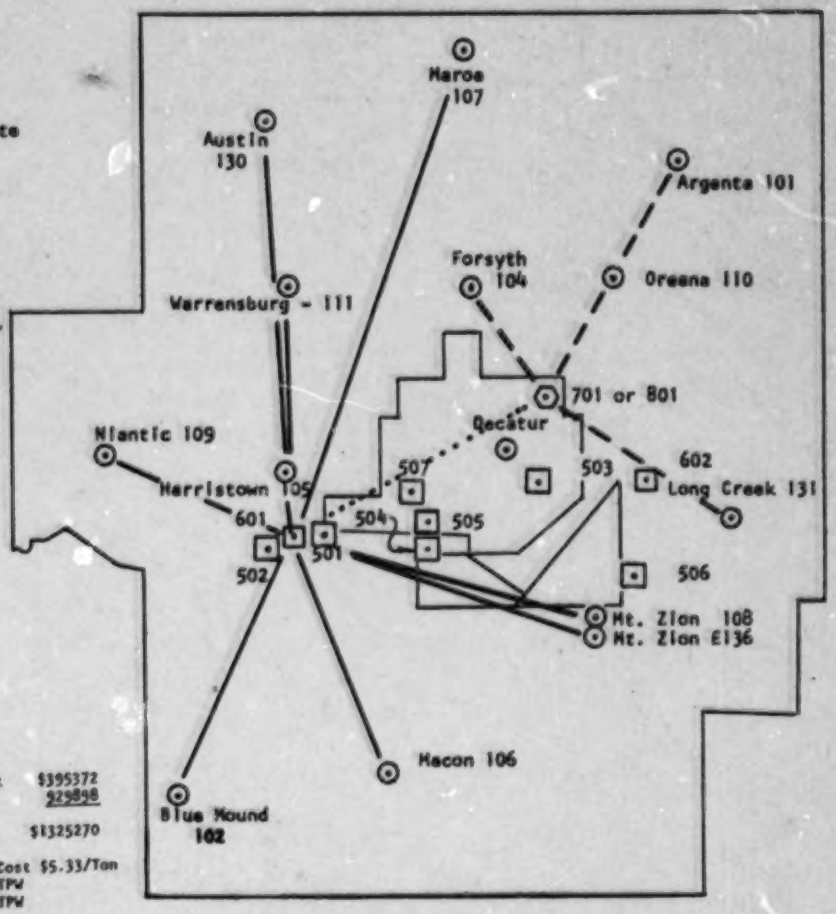
- - - From Source to Intermediate

. . . From Intermediate to Ultimate

HAUL COST ASSUMPTIONS

PACKER Haul Cost $4.36/Ton-Hr.

TRANSFER Haul Cost $1.40/Ton-Hr.



N

Sources

Ultimate Facilities - Land Fills

ID #	Name
501	Macon County
502	Cummins & McKinney
503	Staley
504	Bath
505	Rhodes
506	Cummins
507	Moore's
*601	New 501/502 Fill
602	New Fill Staley

Intermediate Facilities

ID #	Name
*701	Transfer Station
801	Incinerator

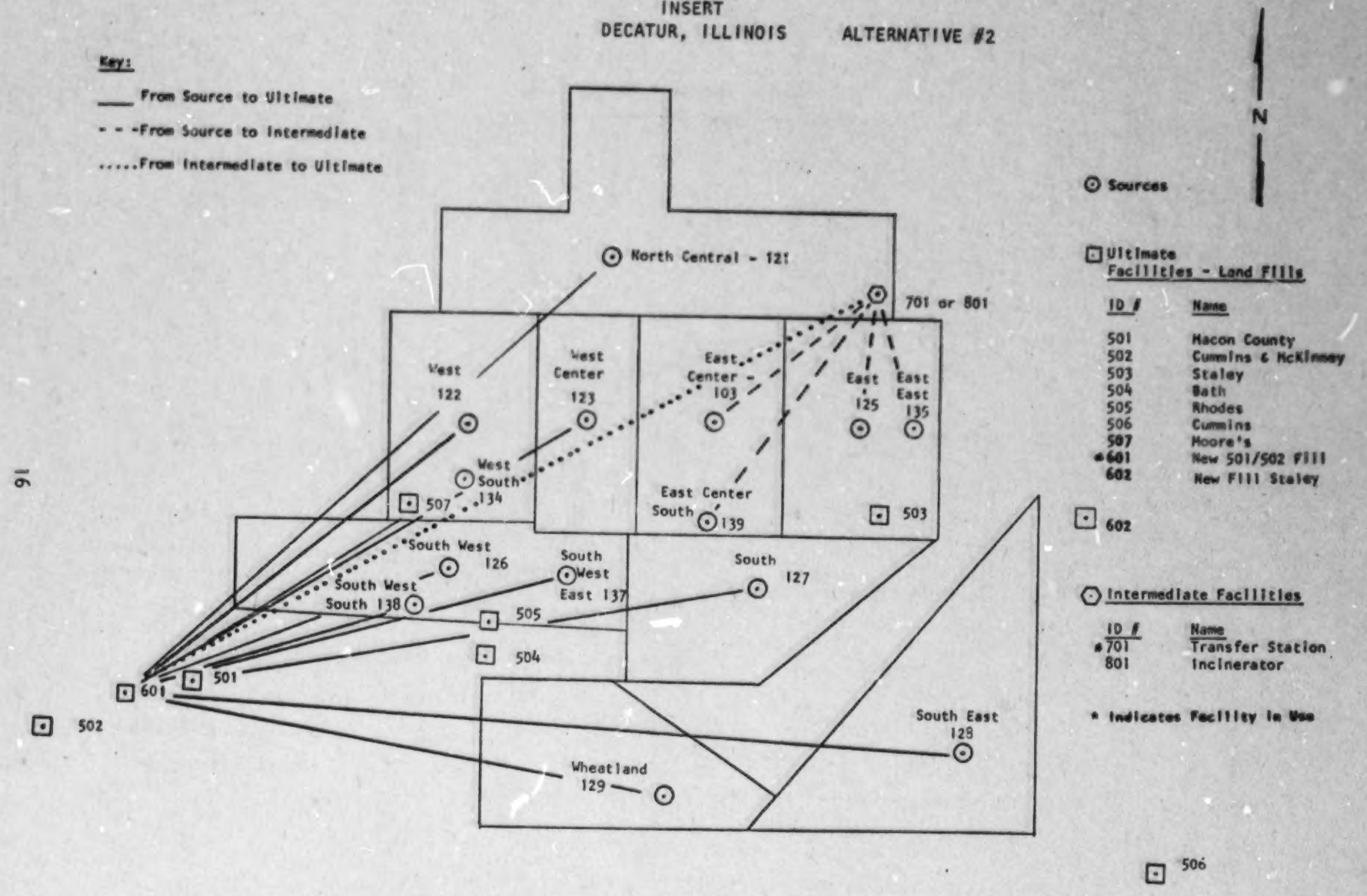
*Indicates Facility in Use

Total Facility Annual Cost	$395372
Total System Haul Cost	929898
Total System Annual Cost	$1325270

Total System Annual Unit Cost $5.33/Ton
Tonnage Handled 601-4786 TPW
701-1046 TPW

See Inset for Decatur Specifics

MACON COUNTY
INSERT
DECATUR, ILLINOIS ALTERNATIVE #2



A county with as much open land as Macon County might reasonably consider the use of one or more sanitary landfills as a long-term solution. A new landfill located in the vicinity of sites 501 and 502 would provide a minimum facility cost and a reasonable total cost, as shown in Alternative #1. Considering the expected increases in quantities and assuming a 40 foot depth of fill, the site would require approximately 230 acres to meet requirements through 1990. Not counting the cost of land, the capital required to construct such a site would be approximately $548,000 (Table B-9, Appendix B). As previously shown, the system unit cost would be on the order of $5.37 per ton.

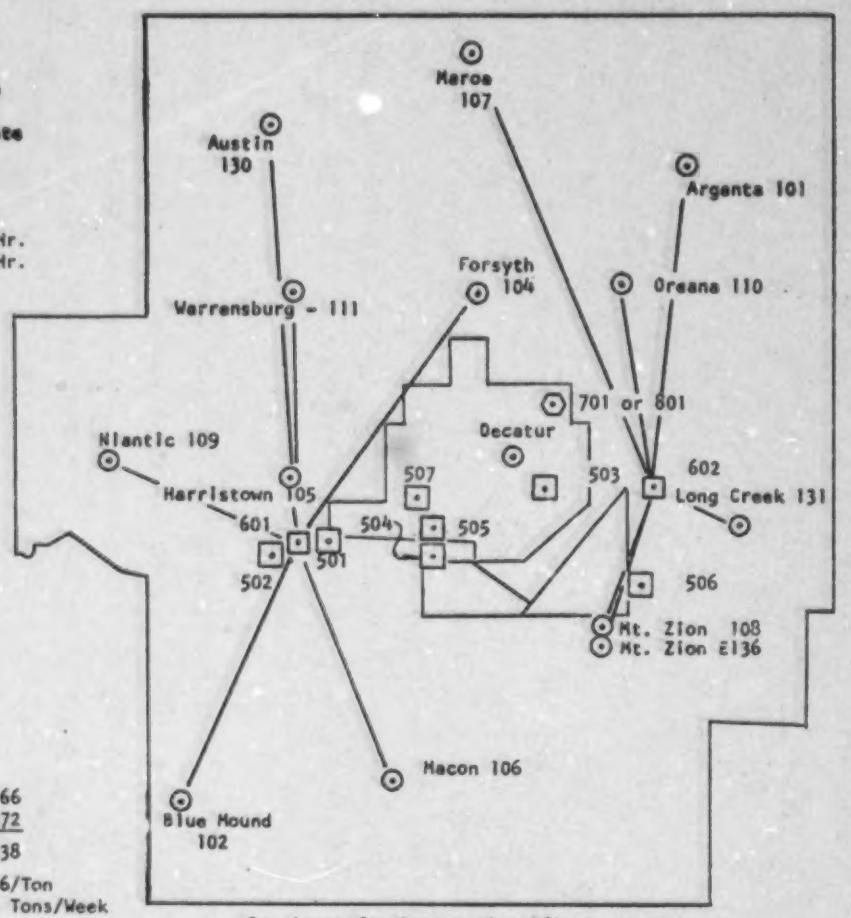
A ideal site for a landfill would be at the population center of the county. Since Decatur has most of the population and is located near the geographical center of the county, it would not be possible to locate a landfill in the most desirable site. Alternative #3 addresses the possibility of having two conveniently located landfills. The increased facility cost is somewhat offset by savings in haul costs. The system annual unit cost of $5.36 is not significantly different from the single landfill alternative. Future changes in fuel cost would increase the attractiveness of this alternative. A county producing 4786 tons per week might also consider the alternative of resource recovery.

One logical system would be to construct a wet-wall incinerator in the industrial park planned for northeastern Decatur. Steam might be sold for heating, cooling and process use. A landfill would be maintained to accommodate incinerator residue, non-combustibles and portions of the total waste which can be more economically delivered to the landfill. Alternative 4 shows the incineration system which provides the lowest total system cost. Approximately 2,000 tons per week of waste from eastern Decatur will go to the incinerator. Wastes from rural areas and the western half of Decatur would go directly to the landfill. The total system cost of $8.42/ton is somewhat misleading. The cost of that portion of the waste which goes to the incineration is approximately $13.00/ton. Justification for this added expenditure is the resource recovery potential which is estimated to be $8.00/ton (Table 10, Chapter 1). The difference between the incinerator cost

MACON COUNTY

2 New Landfills: 601 near 501 and 502, 602 East of Staley. Optimized as both facilities are used and each has an operating capacity large enough for the entire county..

Alternative #3



See Inset for Decatur Specifics

Key:

___ From Source to Ultimate

- - - From Source to Intermediate

. . . From Intermediate to Ultimate

HAUL COST ASSUMPTIONS

Packer Haul Cost	$4.36/Ton-Hr.
Transfer Haul Cost	$1.40/Ton-Hr.

GENERAL COST SUMMARY

Total Facility Annual Cost	$429766
Total System Haul Cost	904972
Total System Annual Cost	$1334738
Total System Annual Unit Cost	$5.36/Ton
Tonnage Handled	4786 Tons/Week

N

⊙ Sources

□ Ultimate Facilities - Land Fills

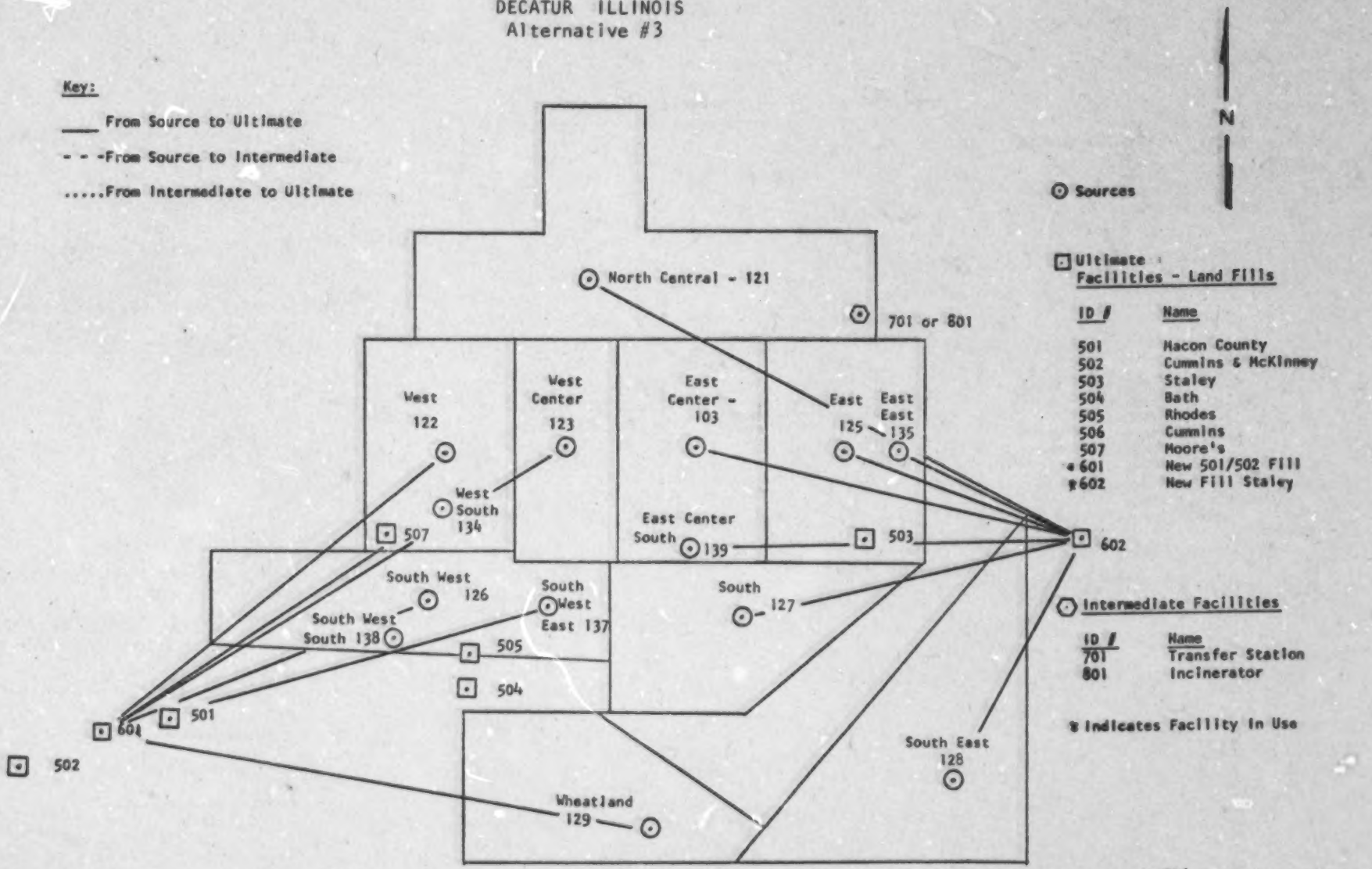
ID #	Name
501	Macon County
502	Cummins & McKinney
503	Staley
504	Bath
505	Rhodes
506	Cummins
507	Moore's
*601	New 501/502 Fill
*602	New Fill Staley

⊙ Intermediate Facilities

ID #	Name
701	Transfer Station
801	Incinerator

* Indicates Facility In Use

MACON COUNTY INSERT
DECATUR ILLINOIS
Alternative #3



MACON COUNTY

Use of a new landfill between 501 and 502 with an incinerator at 801. Incinerator to be used.

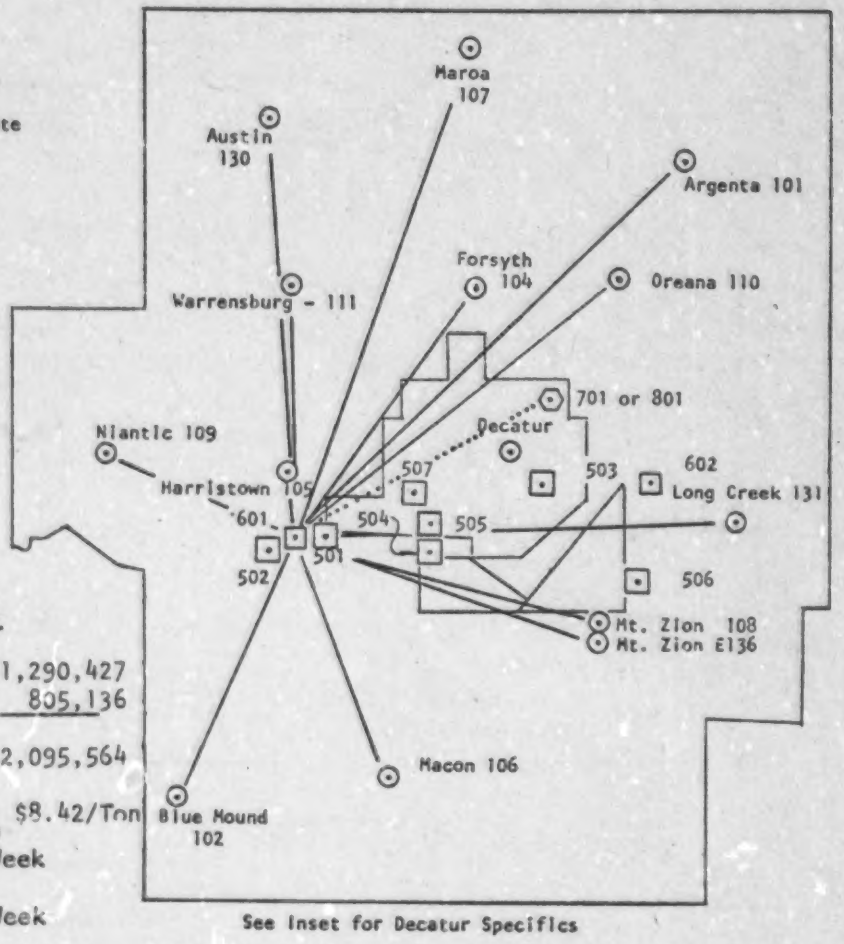
Alternative 4

Key:

___ From Source to Ultimate

- - - From Source to Intermediate

. . . From Intermediate to Ultimate



See Inset for Decatur Specifics

N

⊙ Sources

⊡ Ultimate Facilities - Land Fills

ID #	Name
501	Macon County
502	Cummins & McKinney
503	Staley
504	Bath
505	Rhodes
506	Cummins
507	Moore's
*601	New 501/502 Fill
602	New Fill Staley

⊙ Intermediate Facilities

ID #	Name
701	Transfer Station
*801	Incinerator

*Indicates Facility in Use

HAUL COST ASSUMPTIONS

PACKER Haul Cost $4.36/Ton-Hr.

TRANSFER Haul Cost $1.40/Ton-Hr.

GENERAL COST ANALYSIS

Total Facility Annual Cost	$1,290,427
Total System Haul Cost	805,136
Total System Annual Cost	2,095,564
Total System Annual Unit Cost	$8.42/Ton

Tonnage Handled - Incineration
1,990 Tons/Week

Tonnage Handled - Landfill
3,095 Tons/Week

Macon County Inset

Decatur Illinois

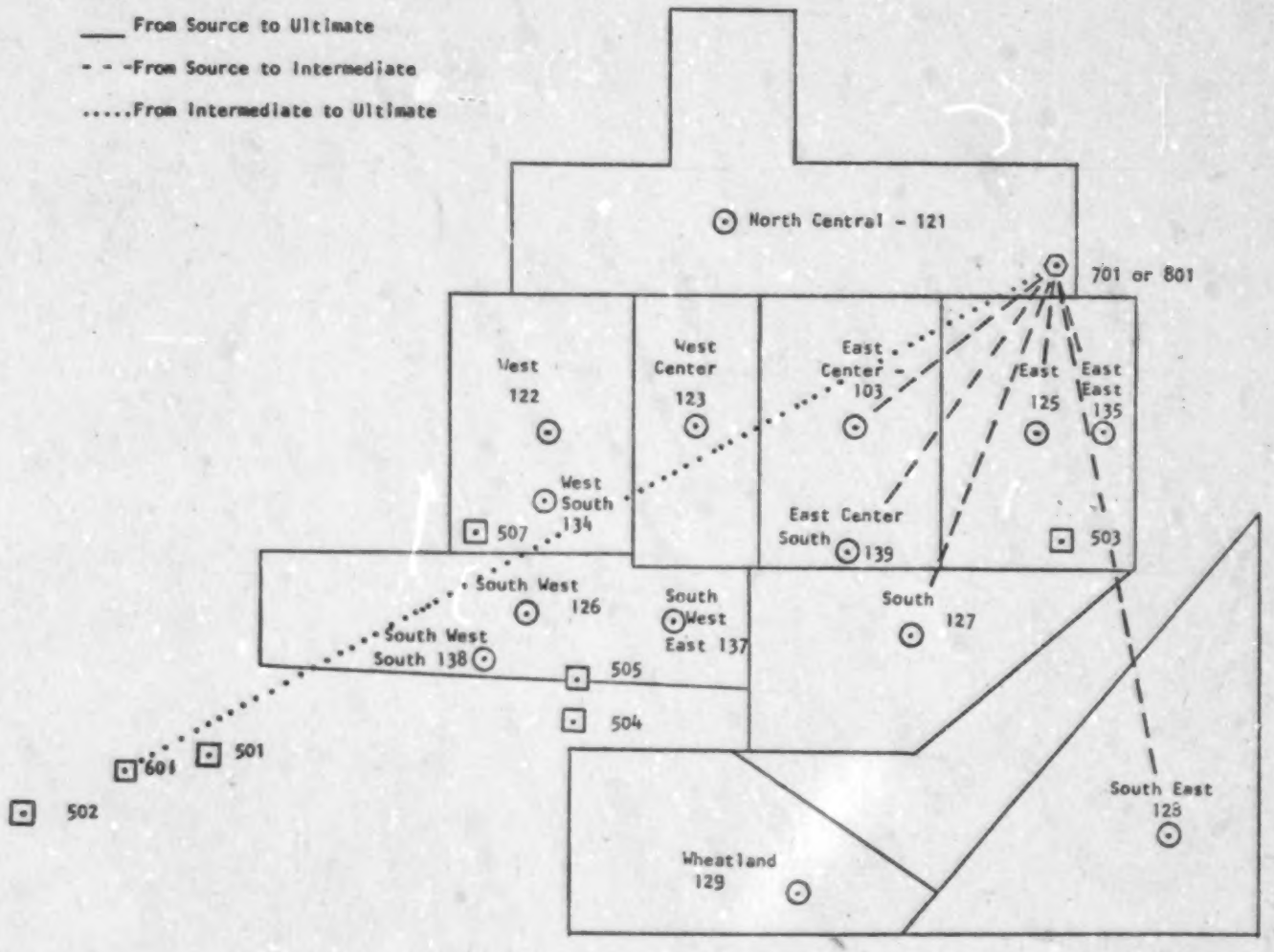
Alternative 4

Key:

____ From Source to Ultimate

- - -From Source to Intermediate

.....From Intermediate to Ultimate



N

⊙ Sources

⊡ Ultimate Facilities - Land Fills

ID #	Name
501	Macon County
502	Cummins & McKinney
503	Staley
504	Bath
505	Rhodes
506	Cummins
507	Moore's
*601	New 501/502 Fill
602	New Fill Staley

⊡ 602

⬡ Intermediate Facilities

ID #	Name
701	Transfer Station
*801	Incinerator

*Indicates Facility In Use

($13.00/ton) and the value of recovered recources ($8.00/ton) is $5.00/ton which is about the same as the cost of landfill disposal. If the value of steam and recovered metals increases, the incineration alternative could become more attractive. The major disadvantage of this alternative is the high capital investment and the probability that the market for steam will require years to develop. Meanwhile, the system will operate at a deficit. The economic risk is further increased by uncertainties as to the value of steam and recovered metal. It would take about five years to design and construct such an incinerator. Lacking a waiting market for steam, this alternative is probably not feasible.

A variation of this alternative would be to install a resource recovery facility (see Table B-10, Appendix B) instead of an incinerator. The plant could be constructed in less time. The minimum cost of such a plant might be $2.6 million - with a design capacity of 500 to 750 tons per day (depending on the number of shifts operated). A facility to process all of Macon County's waste would have a unit cost of $5.90 per ton plus transportation. Again referring to Table 10, Chapter 1, the resource recovery potential might approximate the processing cost. While resource recovery does not require the advance contracts and physical connections required of the steam generation option, markets for recovered waste must be established to provide a continuing, reliable income upon which to base the operation. Many questions will have to be answered, such as: who would own and operate such a plant; how will capital be raised; and how can plant input be assured?

To summarize, both short and long-term solutions will require a new landfill in the Decatur area. If the county does not plan to build a resource recovery system, it might consider two strategically located landfills to reduce haul costs. If the county plans to eventually install a resource recovery system, a single landfill or a single landfill and transfer station located in the industrial park would be logical short-term solutions. The transfer station could provide the basis for a resource recovery system when the resource recovery potential justifies the financial risk.

This study is intended for elected officials, directors of public works, regional planners, and private solid waste operators - all of whom must work together to find acceptable solutions to regional waste problems. Much of this information presented here is subject to change. Planners and engineers who have need to up-date or modify these alternatives may obtain assistance from the Illinois Institute for Environmental Quality.

APPENDIX A

Macon County Information

		Page
1	Geological Information	A-1
2	Population Projections - Table A-1	A-2
3	Employment Projections - Table A-2	A-3
4	Total Solid Waste Quantities - Table A-3	A-5

Geological Information

MACON

Type of Bedrock:	Mainly shale, sandstone and limestone
Drift Thickness:	Between 50 and 200 ft. over most with over 200 in northeast corner.
Type of Drift Mtl:	Till
Glacial Aquifers:	Possibly present
S & G Aquifers:	Northeast corner - extensive, rest - scattered
Limestone Aquifers:	Absent
Sandstone Aquifers:	Possibly present

Non-permeable shale, some water-yielding sandstone and some limestone are the constituents of the bedrock. A large bedrock valley underlies the area from east to west. The glacial drift is over 200 ft. thick in the northwest and central west, while it is between 50 and 200 ft. deep elsewhere. The drift material is till and it is covered by a 4 to 8 foot layer of loess. The sand and gravel aquifers are extensive in the northeast, but scattered over the remainder of the area. No limestone, but sandstone aquifers are present in the county.

With the depth of drift and the type of drift, the bedrock and the sand and gravel aquifers are protected except an area on either side of the Sangamon River. In these areas, the potential for contamination is high. Adequate natural protection for a landfilling operation should be available within the county.

TABLE A-1

PROJECTED POPULATION FOR

MACON COUNTY

LOCATION INCORPORATED	1970*	1975	1980	1985	1990	1995	2000
Argenta	1,034	1,050	1,130	1,230	1,380	1,490	1,630
Blue Mound	1,181	1,170	1,240	1,320	1,440	1,540	1,660
Decatur	87,859	88,200	93,100	99,200	108,000	116,000	125,000
Forsyth	473	470	500	530	580	620	660
Harristown	1,165	1,140	1,210	1,300	1,490	1,630	1,800
Macon	1,249	1,290	1,360	1,450	1,590	1,700	1,830
Maroa	1,467	1,430	1,500	1,590	1,740	1,850	1,990
Mount Zion	2,343	2,190	2,500	2,850	3,310	3,710	4,170
Niantic	750	700	720	750	800	840	880
Oreana	1,092	1,070	1,130	1,220	1,400	1,520	1,690
Warrensburg	738	760	810	870	960	1,030	1,120
SUB TOTAL	99,351	99,500	105,000	112,000	123,000	132,000	142,000
UNINCORPORATED	25,659	29,500	30,500	31,900	34,400	36,200	38,400
COUNTY TOTAL**	125,010	129,000	135,000	144,000	158,000	168,000	180,000

* Census Data Report PC(VI) 15 January 1971

** Summations performed prior to rounding off

TABLE A-2

Macon County

PROJECTED EMPLOYMENT FOR

ARGENTA

SIC	1971	1975	1980	1985	1990	1995	2000
284	2	0	0	0	0	0	0
344	5	5	5	5	5	5	5

BLUE MOUND

271	3	2	2	3	3	2	2
359	15	19	25	33	39	46	52

DECATUR

201	123	89	66	50	36	27	20
2021	16	17	19	23	30	39	52
202	75	120	180	240	340	460	640
204	4000	4370	4920	5460	5990	6520	7050
205	579	600	600	590	600	590	580
208	76	67	58	48	41	35	31
209	504	510	520	540	550	560	580
233	350	370	350	330	310	280	260
237	5	5	5	5	5	5	5
239	20	21	23	26	28	29	30
251	7	23	15	8	5	2	2
254	93	180	250	340	420	490	580
259	7	7	7	7	7	7	7
265	22	49	83	100	140	170	210
271	315	300	300	300	300	290	290
275	105	140	170	210	250	290	330
279	50	58	65	71	79	86	94
283	263	300	360	390	450	490	520
284	16	13	5	2	0	0	0
287	5	2	1	0	0	0	0
295	25	25	25	25	25	25	24
301	1600	2180	2780	3390	3990	4580	5190
307	300	270	260	240	230	210	200
325	12	11	10	10	9	9	9
3272	120	210	300	400	490	580	680
3321	250	270	290	290	310	330	340
336	38	46	53	60	67	74	81
344	704	860	890	930	960	990	1020
346	19	19	19	19	19	19	18
352	170	240	310	390	460	520	600
353	4483	5620	6720	7830	8910	9990	11000
354	10	4	1	0	0	0	0
356	108	100	100	100	100	98	96
357	35	34	33	33	34	32	32
359	47	90	120	160	200	240	270
363	30	51	79	100	130	160	180
365	1400	1650	1860	2080	2310	2530	2730

TABLE A-2 Continued

DECATUR

SIC	1971	1975	1980	1985	1990	1995	2000
371	460	480	410	360	310	270	240
381	150	140	130	130	140	140	150
382	50	80	110	140	170	200	230
385	5	5	5	5	5	5	5
386	80	130	190	260	310	390	440
393	30	22	13	8	5	3	1
394	150	150	140	150	140	130	140
399	52	61	68	76	83	90	96

FORSYTH

251	10	10	10	10	10	10	10

HARRISTOWN

204	5	5	5	5	5	5	5
353	10	10	10	10	10	10	10

MACON

209	5	0	0	0	0	0	0
275	30	35	40	45	50	54	57

MAROA

251	2	6	7	10	13	14	15

MOUNT ZION

251	3	8	12	19	20	22	24
321	450	530	610	710	810	910	990
3272	5	4	4	5	5	5	5
354	10	6	2	0	0	0	0

OREANA

209	10	9	10	10	10	10	10

TABLE A-3

STUDY PERIOD SOURCE INVENTORY

MACON COUNTY

SOURCE NAME	SOURCE ID NO.	1973 VALUES QUANTITY Tons/Week	1990 VALUE QUANTITY Tons/Week
Argenta	101	45.	57.
Blue Mound	102	45.	61.
Decatur E. C.	103	533.	669.
Forsyth	104	21.	28.
Harristown	105	34.	46.
Macon	106	44.	59.
Maroa	107	40.	51.
Mount Zion	108	73.	80.
Niantic	109	25.	31.
Oreana	110	41.	54.
Warrensburg	111	32.	38.
Decatur N. C.	121	706.	900.
Decatur West	122	338.	428.
Decatur W. C.	123	289.	367.
Decatur East	125	351.	444.
Decatur S. W.	126	427.	543.
Decatur South	127	430.	549.
Decatur S. E.	128	586.	746.
Wheatland	129	503.	644.
Austin	130	19.	26.
Long Creek	131	25.	34.
Decatur W. S.	134	10.	66.
Decatur E. E.	135	50.	53.
Mount Zion E.	136	25.	46.
Decatur S. W. E.	137	36.	23.
Decatur S. W. S.	138	18.	51.
Decatur E. C. S.	139	40.	13.
County Totals		4786.	6107.

APPENDIX B

Planning Factors

	Pages
1. Method for calculating municipal and industrial collection rates.	B-1
2. Industrial waste generation factors. Table B-1	B-3
3. Haul Cost Factor with assumptions. Table B-2	B-6
4. Cost Functions: Sanitary Landfill. Figure B-1	B-9
5. Basic Landfill Cost Assumptions For 50, 100, 250, 500, 1000, 2000, and 5000 tons/week. Tables B-3 to B-9	B-10
6. Cost Functions: Intermediate Processing Facilities. Figure B-2	B-18
7. Equations for Facility Cost Functions.	B-19
8. Resource Recovery Facility Description.	B-21
9. Resource Recovery Capital and Annual Cost. Table B-10	B-22

Municipal Generation Rates

The technique selected for estimating present generation rates was developed by Roy F. Weston, Inc. The technique involved the calculation of a generation rate factor which was then multiplied by the population to obtain the generation rate per week for a given geographic area. The generation factor is a function of the population density as shown in the following equations:

$$U = 1.54 \text{ Log } D - 0.68$$

$$V = U \times 7 \text{ day/week} \times 1 \text{ ton/2000 lbs.}$$

$$W = V \times \text{Population within the given area}$$

where: U = per capita waste generation rate in lbs/capita /day

D = population density in person/square miles

V = per capita waste generation rate in tons/capita/week

W = ton per week of waste generated within given area

This relationship is valid in the population density range of 500 - 12,000 persons/square mile. Below the lower limit of the range, the generation factor used is 3.4 lbs/capita/day; above the upper limit, the factor used is 5.6 lbs/capita/day.

Industrial Generation Rate

During the past few years, the Office of Solid Waste Management Programs has funded a number of industrial solid waste surveys to develop solid waste generation factors. A summary of these factors was used to develop industrial solid waste loads by SIC number. The following equation demonstrates the use of the generation factors.

$$I = G.F. \times \text{No. of Employees}$$

$$J = I \div 52$$

where I = yearly production rate in tons/year

$G.F.$ = generation factor in tons/employee/year

J = weekly production rate in tons/week

These relationships are used to estimate probable industrial waste loads, but the yearly employment fluctuation, and generation factors make adjustment necessary for specific locations and plants.

TABLE B-1

Industrial Solid Waste Generation Factors [8]

SIC No.	Name	Generation Factor (tons/employee/year)
201	Meat Products	14.1
2021	Creamery butter	33.0
2022	Cheese, Natural and Processed	169.1
202 (R)[1]	Dairy Products	2.2
203	Canned and Preserved Fruits, Vegetables and Sea Foods	5.4
204	Grain Mill Products	6.2
205	Bakery Products	1.2
206	Sugar	17.2
207	Confectionery and Related Products	3.3
208	Beverages	11.0
209	Miscellaneous Food Preparations and Kindred Products	0.8
211	Cigarettes	1.5
212	Cigars	3.1
213	Tobacco (Chewing and Smoking) and Snuff	0.2
214	Tobacco Stemming and Redrying	4.4
221	Broad Woven Fabric Mills, Cotton	0.4
222	Broad Woven Fabric Mills, Man-made Fiber and Silk	0.7
223	Broad Woven Fabric Mills	0.1
224	Narrow Fabrics and Other Small-wares Mills: Cotton, Wool, Silk and Man-made Fiber	1.2
225	Knitting Mills	1.3
226	Dyeing and Finishing Textiles, Except Wood Fabrics and Knit Goods	2.4
227	Floor Covering Mills	0.2
228	Yarn and Thread Mills	0.7
229	Miscellaneous Textile Goods	4.5
231	Men's, Youths', and Boys' Suits, Coats and Overcoats	0.3
232	Men's, Youths', and Boys' Furnishings, Work Clothing, and Allied Garments	0.3
233	Women's, Misses', and Juniors' Outerwear	0.9
234	Women's, Misses', Children's and Infants' Under Garments	0.4
235	Hats, Caps, and Millinery	0.2
236	Girls', Children's, and Infants' Outerwear	0.9
237	Fur Goods	0.5
238	Miscellaneous Apparel and Accessories	0.4
239	Miscellaneous-Fabricated Textile Products	0.4
241	Logging Camps and Logging Contractors	30.0
2421	Sawmills and planing mills, general	420.0
242 (R)[1]	Sawmills and planing mills	38.7
2432	Veneer and plywood	232.0
243 (R)[1]	Millwork, Veneer, Plywood, and Prefabricated Structural Wood Products	21.7
244	Wooden Containers	16.0
249	Miscellaneous Wood Products	43.0
251	Household Furniture	1.8
252	Office Furniture	2.6
253	Public Building and Related Furniture	1.8
254	Partitions, Shelving, Lockers, and Office and Store Fixtures	3.6
259	Miscellaneous Furniture and Fixtures	1.5
261	Pulp Mills	31.5
262	Paper Mills, Except Building Paper Mills	11.7
263	Paperboard Mills	11.5
264	Converted Paper and Paperboard Products, Except Containers and Boxes	4.0
265	Paperboard Containers and Boxes	12.6
266	Building Paper and Building Board Mills	103.0
271	Newspapers: Publishing, Publishing and Printing	1.1
272	Periodicals: Publishing, Publishing and Printing	0.1
273	Books	0.8
274	Miscellaneous Publishing	0.1
275	Commercial Printing	1.1
276	Manifold Business Forms	4.4
277	Greeting Card Publishing	1.2
278	Blankbooks, Loose Leaf Binders, and Bookbinding and Related Work	2.6
279	Service Industries for Printing Trade	1.4
2819	Industrial Inorganic Chemicals, not Elsewhere Classified	109.0
281 (R)[1]	Industrial Inorganic and Organic Chemicals	18.8
282	Plastics Materials and Synthetic Resins, Synthetic Rubber, Synthetic and Other Man-Made Fibers, Except Glass	16.2

TABLE B-1

Industrial Waste Generation Factors (Continued)

SIC No.	Name	Generation Factor (tons/employee/year)
283	Drugs	3.4
284	Soap, Detergents, and Cleaning Preparations, Perfumes, Cosmetics, and Other Toilet Preparations	3.3
285	Paints, Varnishes, Lacquers, Enamels, and Allied Products	6.2
286	Gum and Wood Chemicals	0.1
287	Agricultural Chemicals	13.5
2891	Adhesives and gelatin	39.4
289 (R)[1]	Miscellaneous Chemical Products	1.2
291	Petroleum Refining	30.6
295	Paving and Roofing Materials	0.9
299	Miscellaneous Products of Petroleum and Coal	9.3
301	Tires and Inner Tubes	3.7
302	Rubber Footwear	2.1
303	Reclaimed Rubber	2.4
306	Fabricated Rubber Products, Not Classified Elsewhere	2.5
307	Miscellaneous Plastics Products	1.3
311	Leather Tanning and Finishing	2.3
312	Industrial Leather Belting and Packing	0.8
313	Boot and Shoe Cut Stock and Findings	1.8
314	Footwear, Except Rubber	0.4
315	Leather Gloves and Mittens	1.3
316	Luggage	7.0
317	Handbags and Other Personal Leather Goods	0.4
319	Leather Goods, Not Elsewhere Classified	0.5
321	Flat Glass	2.5
322	Glass and Glassware, Pressed or Blown	1.4
323	Glass Products, Made of Purchased Glass	1.8
324	Cement, Hydraulic	8.8
325	Structural Clay Products	1.7
326	Pottery and Related Products	3.6
3272	Concrete products, except block and brick	154.0
327 (R)[1]	Concrete, Gypsum, and Plaster Products	15.0
328	Cut Stone and Stone Products	4.2
329	Abrasive, Asbestos, and Miscellaneous Nonmetallic Mineral Products	5.2
3312	Blast Furnaces (including coke ovens), Steel Works, and Rolling Mills	130.0
331 (R)[1]	Blast furnaces, Steel Works, and Rolling and Finishing Mills	3.4
3321	Gray iron foundries	100.0
332 (R)[1]	Iron and Steel Foundries	20.0
3334	Primary production of aluminum	58.0
333 (R)[1]	Primary Smelting and Refining of Nonferrous Metals	2.5
334	Secondary Smelting and Refining of Nonferrous Metals	103.0
335	Rolling, Drawing and Extruding of Nonferrous Metals	5.3
336	Nonferrous Foundries	2.7
339	Miscellaneous Primary Metal Products	2.0
341	Metal Cans	11.2
342	Cutlery, Hand Tools, and General Hardware	2.8
343	Heating Apparatus (Except Electric) and Plumbing Fixtures	7.3
344	Fabricated Structural Metal Products	2.8
345	Screw Machine Products, and Bolts, Nuts, Screws, Rivets and Washers	2.9
346	Metal Stampings	6.2
347	Coating, Engraving and Allied Services	1.5
348	Miscellaneous Fabricated Wire Products	3.1
3491	Metal Shipping Barrels, Drums, Kegs and Nails	13.7
349	Miscellaneous Fabricated Metal Products	1.4
351	Engines and Turbines	1.5
352	Farm Machinery and Equipment	0.9
353	Construction, Mining, and Materials Handling Machinery and Equipment	2.2
354	Metalworking Machinery and Equipment	2.9
355	Special Industry Machinery, Except Metalworking Machinery	0.7
356	General Industrial Machinery and Equipment	1.3
357	Office, Computing, and Accounting Machines	0.8
358	Service Industry Machines	1.5
359	Miscellaneous Machinery, Except Electrical	1.4
361	Electric Transmission and Distribution Equipment	0.8
362	Electrical Industrial Apparatus	0.7
363	Household Appliances	2.4
364	Electric Lighting and Wiring Equipment	2.2
365	Radio and Television Receiving Sets, Except Communication Types	0.8

TABLE B-1

Industrial Waste Generation Factors (Continued)

SIC No.	Name	Generation Factor (tons/employee/year)
366	Communication Equipment	1.9
367	Electronic Components and Accessories	1.0
369	Miscellaneous Electrical Machinery Equipment, and Supplies	2.8
371	Motor Vehicles and Motor Vehicle Equipment	2.4
372	Aircraft and Parts	1.2
3731	Ship Building and Repairing	37.0
3732	Boat Building and Repairing	4.1
374	Railroad Equipment	6.2
375	Motorcycles, Bicycles, and Parts	2.9
379	Miscellaneous Transportation Equipment	1.7
381	Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment	1.1
382	Instruments for Measuring, Controlling, and Indicating Physical Characteristics	0.4
383	Optical Instruments and Lenses	0.5
384	Surgical, Medical, and Dental Instruments and Supplies	2.3
385	Ophthalmic Goods	2.6
386	Photographic Equipment and Supplies	0.4
387	Watches, Clocks, Clockwork Operated Devices, and Parts	0.6
391	Jewelry, Silverware, and Plated Ware	0.8
393	Musical Instruments	0.6
394	Toys, Amusement, Sporting and Athletic Goods	1.7
395	Pens, Pencils, and Other Office and Artists' Materials	0.5
396	Costume Jewelry, Costume Novelties, Buttons, and Miscellaneous Notions, Except Precious Metal	0.3
399	Miscellaneous Manufacturing Industries	2.0

1) Includes the waste in the remainder of the 4-digit codes under this 3-digit code.

TABLE B-2

HAUL COST FACTORS

Type of Truck	Capacity, yd^3	Compacted Density lbs/yd^3	Cost of Truck($)	Life of Truck(yr)	Daily Operating Cost ($)	No. In Crew		Wages, $/hr.(3)				Work-Day (Hrs.)	Work-Week (Days)	Haul Cost ($/ton-hr.)	
								Chicago		Downstate					
						Driver	Laborer	Driver	Laborer	Driver	Laborer			Chicago	Downstate
Rear Loading Compactor	16	500	17,175	5	40	1	1	7.19	6.56	5.70	5.10	8	5	5.10	4.36
Rear Loading Compactor (Municipal	25	500	20,772	5	35	1	2	7.19	6.56	5.70	5.10	8	5	4.28	3.66
Rear Loading Compactor (Private)	25	800	30,444	5	35	1	2	7.19	6.56	5.70	5.10	8	5	2.76	2.32
Front Loading Compactor	30	800	42,875	5	40	1	0	7.19	-	5.70	-	8	5	1.35	1.23
Tilt Frame & 13 Containers	42	500	42,325(1)	5	35	1	0	7.19	-	5.70	-	8	5	1.98	1.75
Tractor & 2 Transfer Trailers	75	500	75,800(2)	5	52	1	0	7.19	-	5.70	-	8	6	1.10	1.00*

(1) Includes the cost of the 13 containers.
(2) Includes the cost of the 2 transfer trailers.
(3) Includes fringe benefits.
* $1.40/Ton-Hr. For Vehicles operated 6 hours per day

ASSUMPTIONS FOR HAUL COST CALCULATIONS

Chicago Area

Assumptions:

1. 45% residential, 30% industrial, & 25% commercial solid waste.
2. 50% private and 50% public collection in the residential sector.
3. Only private collection in the industrial and commercial sectors.
4. 24 yd^3 compactor trucks used for residential collection.
5. Tilt-frame trucks used for industrial collection.
6. 30 yd^3 front loading compactor trucks used for commercial collection.
7. 5 loads/day by tilt-frame trucks.
8. 3 loads/day by front loading compactor trucks.

Haul Costs:

1. From collection route to intermediate facility or disposal site, collection vehicles operate 8 hours per day.
2. From intermediate facility to disposal site, vehicles operate 8 hours per day - $1.10/ton-hr.

Downstate

Assumptions:

1. 75% residential, 15% industrial, and 10% commercial solid waste.
2. 50% private and 50% public collection in the residential sector.
3. Only private collection in the industrial and commercial sectors.
4. 25 yd^3 compactor trucks used for residential collection.

5. Tilt-frame trucks used for industrial collection.

6. 30 yd^3 front loading compactor trucks used for commercial collection.

7. 5 loads/day by tilt-frame trucks.

8. 3 loads/day by front loading compactor trucks.

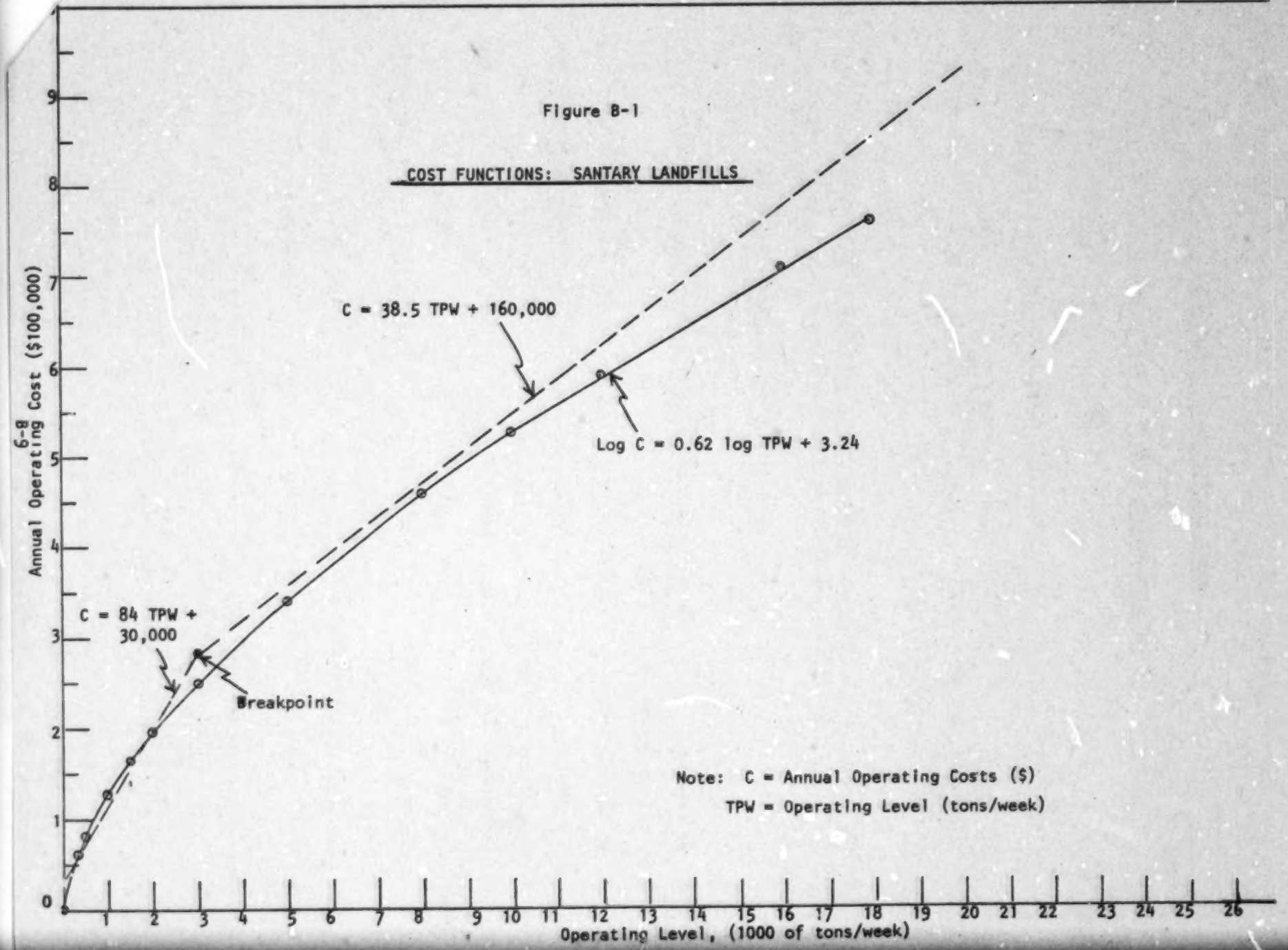
Haul Costs:

1. From collection route to intermediate facility or disposal site, collection trucks operate 8 hours per day.

2. From intermediate facility to disposal site where total loads are less than 150 tons/day, vehicles operate 6 hours per day - $1.40/ton-hr. For total loads greater than 150 ton/day, vehicles operate 8 hours per day - $1.00/ton-hr.

Figure B-1

COST FUNCTIONS: SANTARY LANDFILLS



BASIC LANDFILL COST ASSUMPTIONS

TABLE B-3
ASSUMING EXCAVATION DONE BY RENTED OR LEASED UNIT

50 TPW

EQUIPMENT TABLE A

Farm	CAPITAL COST		OWNING		O&M
Tractor & Loader or Blade	$15,000	@ 22%	$3,600	@24%	$3,300
Fuel	500		119		50
	$15,500		$3,719		$3,350

PERSONNEL COST-TABLE B

Supervisor & Operator @ $11.50/Hr. and fringe for 2 days a week - $184./Wk.
$9568./Per Year

FACILITY COST ESTIMATE- TABLE C

		Yr.	CC	@%	AC
1.	Design	25	$ 9,000	8	720
2.	Preparation	25	12,000	8	840
3.	Building Facilities	25	1,000	8	80
4.	Equipment	varies	$15,500		3,719
	Sub-Total		$37,500		
5.	Supervision & Inspection	25	2,510	8	201
	Sub-Total		$40,010		
6.	Contingency 10%	25	4,001	8	320
	Sub-Total		$44,011		
7.	Legal 3%	25	1,320		106
	Sub-Total		$45,331		
8.	Bond Discount 3%	25	1,360		109
	TOTAL CAPITAL COST		$46,691		6095.

ANNUAL COST	
A. Sum of 1-8	$6,095
B. Equipment	3,350
Facility 50% of CC-3	500
Miscellaneous 3% of CC-2	360
C. Salaries	9,568
Overhead	
Total Annual Cost	$19,873
Annual Cost/Ton	$ 7.64
@ 52 Weeks	
@ 50 TPW	

O&M- OPERATION AND MAINTENANCE
Yr.- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-4

BASIC LANDFILL COST FUNCTION ASSUMPTIONS

100 TPW

EQUIPMENT TABLE A

	CAPITAL COST	OWNING		O&M	
Tractor & Loader or Blade	$15,000	24%	$3,600	30%	$4,500
Fuel	500		119		50
	$15,500		$3,719		$4,550

PERSONNEL COST TABLE B

Supervisor and Operator @ $11.50/Hr. include Fringe for 4 days a week - $19,136

FACILITY COST ESTIMATE TABLE C

		YR	CC	@%	AC
1.	Design	25	$10,000	8	$ 800
2.	Preparation	25	13,000	8	1,040
3.	Building Facilities	25	1,000	8	80
4.	Equipment	varies	15,500		3,719
	Sub-Total		$39,500		
5.	Supervision & Inspection	25	3,020		242
	Sub-Total		$42,520		
6.	Contingency - 10%	25	4,252		340
	Sub-Total		$46,772		
7.	Legal 3%	25	1,403		112
	Sub-Total		$48,175		
8.	Bond Discount 3%	25	1,445		116
	TOTAL CAPITAL COST		$49,620		$6,449

ANNUAL COST	
A. Sum of 1-8	$ 6,449
B. Equipment	$ 4,550
Facility 50% of CC-3	500
Miscellaneous 3% of CC-2	390
C. Salaries	$19,136
Total Annual Cost	$30,975
Annual Cost/Ton @ 52 Weeks @ 100 Tons	$5.96

O&M- OPERTION AND MAINTENANCE
Yr.- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-5

BASIC LANDFILL COST ASSUMPTIONS

250 TPW

EQUIPMENT TABLE A

	YEAR	CAPITAL COST	%	OWNING	%	O & M
Crawler	5	$36,000	24	$8,546	22	$8,000
Fuel	5	500	24	119		50
		$36,500		$8,665		$8,050

PERSONNEL COST TABLE B

		ANNUAL
1 Laborer $4/Hr.- 2080	Fringes	$8,320
1 Operator & Supervisor $11.50/Hr - 2080	"	24,000
		$32,320

FACILITY COST ESTIMATE TABLE C

		Yr.	CC	@%	AC
1.	Design	25	$11,000	8	$ 880
2.	Preparation	25	14,000	8	1,120
3.	Building Facilities	25	1,000	8	80
4.	Equipment	varies	36,500		8,665
	Sub-Total		$62,500		
5.	Supervision & Inspection 2% of 4	25	3,330	8	266
	Sub-Total 10% of 1-3		$65,830		
6.	Contingency 10%	25	6,583	8	527
	Sub-Total		$72,413		
7.	Legal 3%	25	2,172	8	174
	Sub-Total		$74,585		
8.	Bond 3%	25	2,238	8	179
	TOTAL CAPITAL COST		$76,823		$11,891

	ANNUAL COST
A. Lines 1-8	$11,891
B. Equipment	8,050
Facility 50% of CC-3	500
Miscellaneous 3% of CC-2	420
C. Salaries	$32,320
Total Annual Cost	$53,181
Annual Cost/Unit	$ 4.13/Ton

O&M- OPERATION AND MANTENANCE
Yr.- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-6

BASIC LANDFILL COST ASSUMPTIONS

500 TPW

EQUIPMENT - TABLE A

	YEAR	CAPITAL COST	%	OWNING	%	O&M
Crawler 195Hp	5	$58,000	24	$13,779	24	$13,800
Fuel	5	800		190		100
Scales	10	$ 7,500	14	1,019	8	600
		$66,300		$14,988		$14,500

LABOR TABLE B

Supervisor Scale Man $4/Hr. $5/Hr.	$11,000
Operator @ $11.50 for 2080 Hr.	24,000
Laborer $4.00/Hr. for 2080 Hr.	8,320
	$4 ,320

FACILITY COST ESTIMATE TABLE C

		YR.	CC	@%	AC
1.	Design	25	$15,000	8	$ 1,173
2.	Preparation	25	20,000	8	1,565
3.	Building Facilities	25	8,000	8	640
4.	Equipment	Varies	66,300		14,988
	Sub-Total		$109,300		
5.	Supervision & Inspection	25	5,626	8	450
	Sub-Total		$114,926		
6.	Contingency 10%	25	11,493	8	919
	Sub-Total		$126,419		
7.	Legal 3%	25	3,793	8	303
	Sub-Total		$130,212		
8.	Bond Discount 3%	25	3,906	8	312
	TOTAL CAPITAL COST		$134,118		$20,350

ANNUAL COST	
A. Line 1-8	$20,350
B. Equipment	14,500
Facility ≈50% of CC-3	3,500
Miscellaneous 3% of CC-2	600
C, Salaries	43.320
Total Annual Cost	82,370
Annual Unit Cost	$3.16/Ton

O&M- OPERTION AND MAINTENANCE
Yr.- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-7

BASIC LANDFILL COST ASSUMPTIONS
1000 TPW

EQUIPMENT - TABLE A

	YR.	CC	%	OWNING	%	OPERATION & MAINTENANCE
1 115Hp Crawler	5	$ 36,000	24	$ 8,546	22	$ 8,000
1 170Hp Crawler	5	52,000	24	12,345	22	12,000
1 Fuel Port	5	3,000	24	712	7	200
Scales	10	10,000	14	1,359	10	1,000
		$101,000		$22,962		$21,200

PERSONNEL - TABLE B

Super & Scalemen	1	@ 2080 Hr. @ $8.17/Hr.	$17,000
Equip. Oper. 1.5	1.5	$24,000/Year	36,000
Labor	2		16,640
			$69,640

FACILITY COST ESTIMATE TABLE C

	YR.	CC	@%	A.C.	ANNUAL COST	
1. Design	25	$ 17,500	8	$1,369		
2. Preparation	25	25,000	8	1,956	A. Line 1-8	$29,611
3. Building Facilities	25	8,000	8	640		
4. Equipment	Varies	101,000	-	22,962	B. Equipment	21,200
Sub-Total		$151,500			Facility 50% of CC-3	4,000
5. Supervision & Inspection	25	7,070	8	566	Miscellaneous 3% of CC-2	750
Sub-Total		$158,570				$55,561
6. Contingency 10%	25	15,857	8	1,269	C. Salaries	69,640
Sub-Total		$174,427				
7. Legal 3%	25	5,233	8	418		
Sub-Total		$179,660				
8. Bond Discount 3%	25	5,390	8	431	Total Annual	$125,201
TOTAL CAPITAL COST		$185,050		$29,611	Annual Unit Cost at 962 T/W at 52 W/Yr.	$2.50/Ton

O&M- OPERATION AND MAINTENANCE
Yr,- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-8

BASIC LANDFILL COST ASSUMPTIONS

2000 TPW

EQUIPMENT TABLE A

	YR.	CAPITAL COST	%	OWNING	%	O&M
Crawler 195 Hp.	5	$ 58,000	24	$13,770	24	$13,800
Crawler 300 Hp.	5	86,000	24	20,417	22	19,000
Front End Loader 100 Hp.	5	31,000	24	7,360	19	6,000
Fuel Supply	5	5,000	24	1,187	8	400
Scale	10	11,000	14	1,495	14	1,500
		$191,000		$44,229		$40,700

PERSONNEL COSTS TABLE B

Supervisor & Scale	1 @ 2080 @ $8.2/Hr.	$17,056
Laborer	2 @ 2080 @ $4./Hr.	16,640
Equip. Operator	2.5 @ $11.50/Hr and 2080 Hrs.	59,800
		$93,496

FACILITY COST ESTIMATE TABLE C

		YR.	CC	@%	AC
1.	Design	25	$20,000	8	$ 1,565
2.	Site Preparation	25	30,000	8	2,347
3.	Building Facilities	25	21,620	8	1,691
4.	Equipment	Varies	191,000	-	44,229
	Sub-Total		$262,620		
5.	Supervision & Inspection	25	10,982	8	879
	Sub-Total		$273,602		
6.	Contingency - 10%	25	27,360	8	2,189
	Sub-Total		$300,962		
7.	Legal 3%	25	9,029	8	722
	Sub-Total		$309,991		
8.	Bond Discount 3%	25	9,299	8	744
	TOTAL CAPITAL COST		$319,290		$54,366

ANNUAL COST

A. Lines 1-8	$54,366
B. Equipment	40,700
Facility 50% of CC-3	10,810
Miscellaneous 3% of CC-2	900
C. Salaries	93,496
Total Annual Cost	$200,272
Annual Unit Cost	$2.00/Ton

O&M- OPERATION AND MAINTENANCE
Yr.- NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST
@% - % CAPITAL RECOVERY PER YEAR
AC- ANNUAL CAPITAL RECOVERY VALUE

Table B-9

BASIC LANDFILL COST ASSUMPTIONS

5000 TPW

EQUIPMENT TABLE A

NO.	YR.	CAPITAL COST	%	OWNING	%	O&M
1. Crawler 195Hp.	5	$ 58,000		$13,770		$13,800
2. Crawler 300Hp.	5	86,000		20,417		19,000
170Hp.	5	52,000		12,345		12,000
1. Loader 300Hp.	5	31,000		7,360		6,000
1. Scraper 150Hp.	5	49,000		11,633		18,000
1. Truck Pick-Up	4	4,000	29	1,160	46	1,840
1. Fuel Truck	5	13,000	24	3,086	35	4,500
1. Water Tank Truck	5	12,000	24	2,849	35	4,000
Motor Grador	5	31,000	24	7,360	13	4,000
Scale	10	25,000		3,397		3,000
		$361,000		$83,377		$86,140

PERSONNEL COSTS TABLE B

5 Operators @ $11.50/Hr. @2080	$120,000	
4 Laborer $4.00/Hr.	33,280	
2 Scale Operator @ $11066./Year	22,132	Based on Ratio of Lab/Sc.Op.
1 Supervisor @ $17,000 @ $8.2/Hr.	17,000	Based on Ratio of Sc. Op/Sup.

FACILITY COST ESTIMATE TABLE C

		YR.	CC	@%	AC
1.	Design	25	$ 25,000	8	$ 1,956
2.	Preparation	25	40,000	8	3,129
3.	Building Facilities	25	27,244	8	2,131
4.	Equipment	Varies	361,000	-	83,377
	Sub-Total		$453,244		
5.	Supervision & Inspection	25	16,444		1,316
	Sub-Total		469,688		
6.	Contingency 10%	25	46,969		3,758
	Sub-Total		$516,657		
7.	Legal 3%	25	15,500		1,240
	Sub-Total		$532,157		
8.	Bond Discount 3%	25	15,965		1,277
			$548,122		$98,184

O&M - OPERATION AND MAINTENANCE
Yr. - NUMBER OF YEARS AMORTIZED OVER
CC - CAPITAL COST

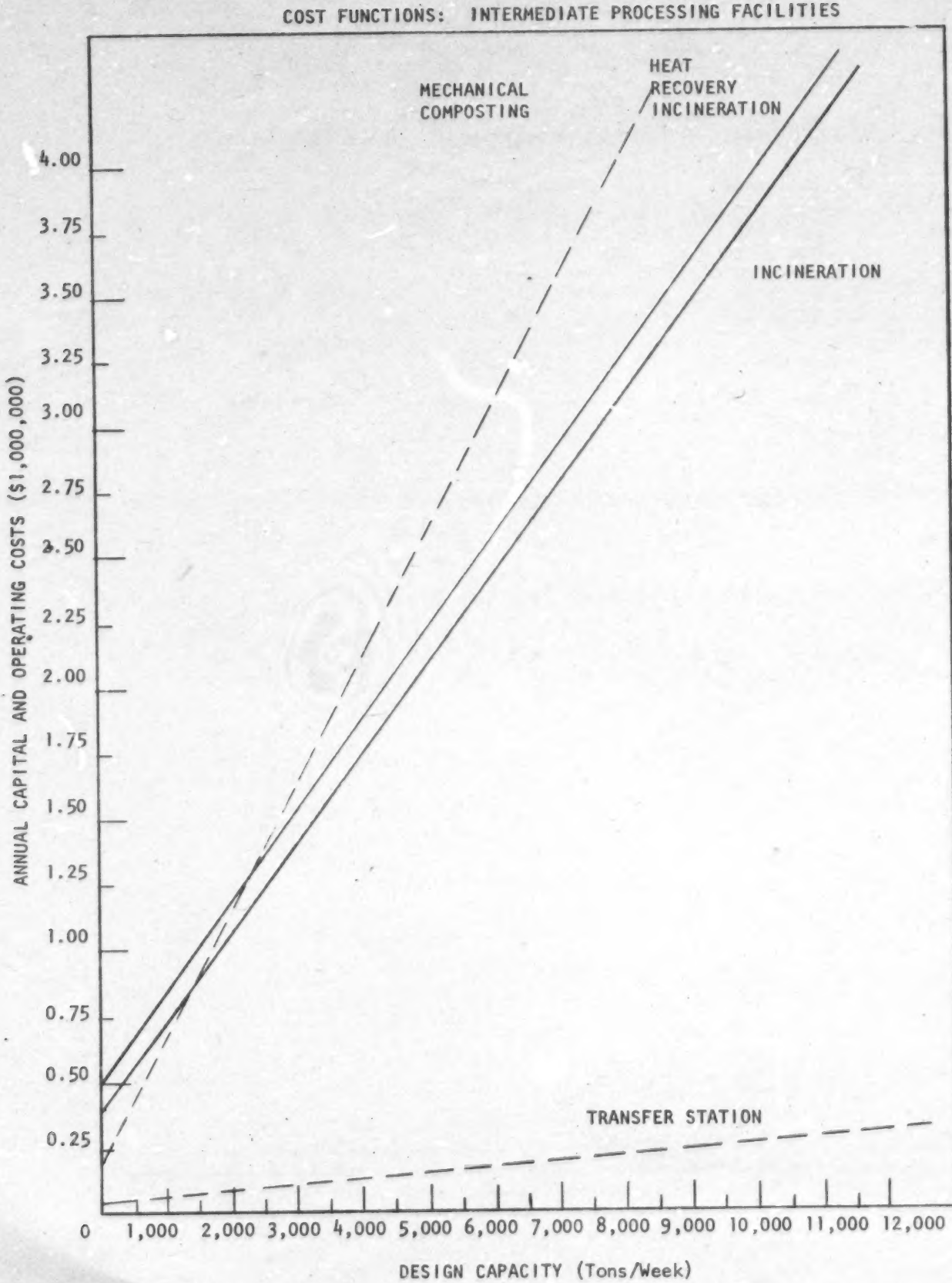
@% - % CAPITAL RECOVERY PER YEAR
AC - ANNUAL CAPITAL RECOVERY VALUE

TABLE B-9 Continued

A.	Sum 1-8	$98,184
B.	Equipment	86,140
	Facility	13,622
	50% of CC - 3 Miscellaneous	1,200
	3% of CC - 2	
C.	Salaries	$192,412
	Annual Cost	$391,558
	Annual Unit Cost	$1.50/Ton

Figure B-2

COST FUNCTIONS: INTERMEDIATE PROCESSING FACILITIES



EQUATIONS FOR FACILITY COST FUNCTIONS

Transfer Station

$C = 22\ TPW + 40{,}000$

Where C = Annual capital and operating cost ($)

TPW = Design capacity of facility (tons/week)

NOTE: Does not include transport costs.

Compost Plant

Mechanical Digestion:

$C = 500\ TPW + 200{,}000$

Where C = Annual capital and operating cost ($)
TPW = Design capacity of facility (tons/week)

NOTE: 1) Cost of residue disposal not included. Approximately 15% of solid waste input must be disposed of when salvage is not practiced; 5% when salvage is practiced.

2) No credit is given for sale of the end product or the salvaged materials. Approximately 33% of the input quantity emerges as compost, and glass and ferrous salvage usually amount to 5% each of the input quantity.

Incinerator

Standard:

$C = 320\ TPW + 400{,}000$

With Power Production

$C = 340\ TPW + 500{,}000$

Where C = Annual capital and operating cost ($)
TPW = Design capacity of facility (tons/week)

NOTE: 1) Continuous - feed furnaces

2) Air pollution control equipment included

3) No credit is given for the sale of power

Sanitary Landfill

Capital Cost: Consultant's estimate for each individual case.

Operating Cost:

$C = 84\ TPW + 30,000$ when $TPW \leq 3,000$
$C = 38.5\ TPW + 160,000$ when $TPW > 3,000$

Where C = Annual operating cost ($)
TPW = Operating level (tons/week)

The curve that best fit the cost data is described by the following equation:

$$C = 0.62 \log TPW + 3.24$$

Since only linear equations are acceptable to the optimization routine, two linear equations were fitted to the curve aroung the specified breakpoint which yielded the two linear equations above.

RESOURCE RECOVERY FACILITY AND COST

The following system was designed to process up to 750 tons per day of municipal solid waste based upon a 2-shift operation. The system will shred all waste, magnetically separate ferrous metals and separate heavy and light fractions. Two shredders are provided to assure continuous service. The system will produce: shredded fuel, ferrous metals, and a mixture of glass and non-ferrous metals.

This estimate does not include the power plant handling and transportation costs. Included in the building cost is a pile foundation.

This system was designed in 1973 for the City of New Orleans by the National Center for Resource Recovery, but has not been constructed. The construction and operating costs included herein are unvarified estimates of cost.

TABLE B-10

FACILITY (750 Tons/Day, 2 Shift)

	MATERIALS	LABOR
Scale	57,375	6,715
Front End Loader	58,300	-
Municipal Solid Waste Conveyor System	201,235	14,740
Reject Bin (large objects)	6,985	-
Trommel Screen	143,185	11,120
Trommel Discharge Conveyor	12,445	19,085
Shredder Feed Conveyor	20,005	19,085
Shredder (2)	569,615	18,790
Shredder Discharge Conveyor	45,545	805
Air Classifier	270,960	42,190
Magnetic Separator	28,000	7,000
By-pass Conveyor	25,380	2,115
Shredder Materials Conveyor System	58,235	2,115
Heavy Materials Conveyor System	25,875	4,935
Electrical System	51,650	10,075
	$1,574,890	$158,770
Building, Receiving (1,000 Ton Storage)	182,880	14,590
Asphalt Apron	14,750	12,010
Shredder Building	113,305	79,500
	$ 310,935	$106,100
Engineering, Contingencies, Profit	510,385	
Total Cost	$2,661,080	

TABLE B-10 (Continued)

OPERATING COST

Amortization (10 Years @ 8%)

2,661,080 (CRF 10 Years @ 8%) 0.149 ÷ 12 =	45,500
Power, water	14,538
Shredding	23,469
Recovery	28,608
Cost per Month	$112,015

Total Annual Cost $1,340,000

750 Tons/Day x 6 Day/Week x 52 Weeks/year = 234,000 Tons/Year

Cost per Ton = $5.73

@ 500 Tons/Day x 312 Days/Year = 156,000 Tons

Cost Per Ton = $8.60